

CLAIMS

What is claimed is:

1. An apparatus comprising:

a data requestor which has the ability to specify demand data that it wants and to receive reply data including the demand data and optionally also unspecified prefetch data;
a communication link; and
a data source coupled to the data requestor over the communication link and which has the ability to determine which prefetch data to send to the data requestor with the demand data.

2. The apparatus of claim 1 wherein:

the data requestor comprises a driver; and
the data source comprises a storage system.

3. The apparatus of claim 2 wherein the storage system comprises:

a rotating storage drive.

4. The apparatus of claim 3 wherein:

the data requestor further comprises a data destination buffer; and
the data source further has the ability to write the prefetch data and the demand data into the data destination buffer, and the ability to provide data identifiers which enable the data requestor to selectively retrieve the demand data from the data destination buffer.

5. The apparatus of claim 4 wherein the apparatus comprises a computer.

6. The apparatus of claim 1 wherein the communication link comprises a local area network.

7. The apparatus of claim 1 wherein the communication link comprises a wide area network.

8. The apparatus of claim 1 wherein the communication link comprises the internet.

9. The apparatus of claim 1 wherein the communication link comprises a host disk controller.

10. The apparatus of claim 1 wherein the prefetch data are stored contiguously with the demand data in a storage device of the data source.

1 11. The apparatus of claim 1 wherein the data requestor specifies null demand data.

1 12. A storage system for responding to a demand data request from a data requestor, the storage
2 system comprising:

3 a controller for performing logic operations of the storage system;

4 a storage drive coupled to the controller;

5 a storage cache coupled to the controller; and

6 at least one prefetch algorithm executable by the controller to determine which prefetch data
7 to include with demand data in a response to the demand data request, and to retrieve the prefetch
8 data and the demand data from at least one of the storage drive and the storage cache, and to provide
9 to the data requestor reply data including the prefetch data and the demand data.

1 13. The storage system of claim 12 wherein:

2 the storage drive comprises a rotating storage drive; and

3 the at least one prefetch algorithm includes the ability to utilize a rotation state of the rotating
4 storage drive in determining which prefetch data to include with the demand data in the response.

1 14. The storage system of claim 13 wherein:

2 the rotation state includes whether the prefetch data will arrive at a read head of the rotating
3 storage drive before the demand data, or after the demand data.

1 15. The apparatus of claim 12 wherein the demand data request specifies null demand data.

1 16. The apparatus of claim 12 wherein the prefetch data are contiguous with the demand data on
2 the storage drive.

1 17. The apparatus of claim 16 wherein the prefetch data include prefetch data which are stored
2 prior to the demand data and prefetch data which are stored after the demand data on the storage
3 drive.

1 18. The apparatus of claim 12 wherein the reply data further include information enabling the
2 data requestor to select the demand data from the reply data.

1 19. A storage driver for execution by a data requestor to retrieve demand data from a storage
2 system, the storage driver comprising:

3 means for identifying the demand data to the storage system;

4 means for receiving reply data from the storage system, in which the reply data includes the
5 demand data and potentially also prefetch data which was not identified by the storage driver; and

6 means for selectively retrieving the demand data out of the reply data.

1 20. The storage driver of claim 19 further comprising:

2 means for selectively retrieving the prefetch data out of the reply data; and

3 means for caching the prefetch data.

1 21. The storage driver of claim 20 further comprising:

2 means for receiving an offset into the reply data at which the demand data is located.

1 22. The storage driver of claim 21 further comprising:

2 means for receiving an indication of how much reply data has been received from the storage
3 system.

1 23. The storage driver of claim 22 wherein the storage system comprises a disk drive and the
2 storage driver comprises disk drive driver software executable by a microprocessor of a computer
3 system which is connected to the disk drive.

1 24. The storage driver of claim 19 wherein the means for selectively retrieving the demand data
2 is adapted to retrieve the demand data from between first prefetch data stored below the demand data
3 and second prefetch data stored above the demand data in the means for receiving reply data.

1 25. A method comprising:

2 a driver requesting specified demand data from a storage system;

3 the storage system determining which prefetch data to include with the demand data; and

4 the driver receiving from the storage system,

5 the demand data, and

6 the prefetch data.

1 26. The method of claim 25 wherein:

2 the storage system determines which prefetch data to include, based at least in part on a state
3 of the storage system.

1 27. The method of claim 26 wherein the state comprises whether the prefetch data is already in a
2 storage cache in the storage system.

1 28. The method of claim 27 wherein the state further comprises whether the prefetch data can be
2 retrieved from a storage drive with an acceptable performance penalty.

1 29. The method of claim 25 further comprising:

2 the driver receiving from the storage system information identifying where, within reply data
3 that includes the demand data and the prefetch data, the demand data is located.

1 30. The method of claim 29 wherein the storage system provides, in the information, a demand
2 data offset and a reply length.

1 31. The method of claim 25 wherein the driver and the storage system are connected by a
2 communication link.

1 32. The method of claim 31 wherein the communication link comprises the internet.

1 33. The method of claim 32 wherein the communication link comprises a local area network.

1 34. The method of claim 31 wherein the method is performed by a computer system, the driver is
2 executed by a microprocessor of the computer system, the storage system comprises a disk drive
3 system of the computer system, and the communication link comprises a host disk controller
4 interface to the storage system.

1 35. A method of operating a storage device driver in a processor-based system which includes a
2 storage system, the method comprising:

3 receiving a first request for demand data;

4 sending a second request for the demand data to the storage system;

5 receiving reply data from the storage system;

6 receiving identifying data from the storage system; and

7 using the identifying data to selectively retrieve the demand data from the reply data.

1 36. The method of claim 35 further comprising:
2 using an offset indicator in the identifying data to identify a beginning location of the demand
3 data in a buffer in which the reply data were received.

1 37. The method of claim 36 further comprising:
2 using a reply length indicator in the identifying data to determine how much prefetch data
3 were received from the storage system in the reply data with the demand data.

1 38. The method of claim 37 further comprising:
2 caching the prefetch data.

1 39. The method of claim 35 wherein the reply data comprises prefetch data and the demand data.

1 40. The method of claim 39 wherein the demand data and the prefetch data are from contiguous
2 areas of storage.

1 41. The method of claim 39 wherein the demand data and the prefetch data are from
2 discontinuous areas of storage.

1 42. A method of operating a storage system in conjunction with a data requestor which does not
2 specify how much prefetch data the storage system should return with demand data requested by the
3 data requestor, the method comprising:

4 sending the demand data to the data requestor;
5 determining what prefetch data to include with the demand data;
6 sending the prefetch data to the data requestor; and
7 providing identifying data to enable the data requestor to discern the demand data from the
8 prefetch data.

1 43. The method of claim 42 wherein the determining what prefetch data to include comprises:
2 basing the determination at least in part on a state of the storage system.

1 44. The method of claim 43 wherein the state comprises whether the prefetch data are cached.

1 45. The method of claim 44 wherein the state further comprises whether the demand data are
2 cached.

1 46. The method of claim 45 wherein the state comprises whether the prefetch data can be
2 retrieved from a storage drive before the demand data can.

1 47. The method of claim 45 wherein the state comprises whether the prefetch data can be
2 efficiently retrieved following the demand data.

1 48. The method of claim 47 wherein the state comprises whether the prefetch data will cause a
2 head seek.

1 49. An article of manufacture comprising:
2 a machine-accessible medium including data that, when accessed by a machine, cause the
3 machine to perform the method of claim 35.

1 50. The article of manufacture of claim 49 wherein the machine-accessible medium further
2 includes data that cause the machine to perform the method of claim 37.

1 51. The article of manufacture of claim 49 wherein the machine-accessible medium comprises a
2 recordable storage medium.

1 52. The article of manufacture of claim 49 wherein the machine-accessible medium comprises a
2 carrier wave.

1 53. An article of manufacture comprising:
2 a machine-accessible medium including data that, when accessed by a machine, cause the
3 machine to perform the method of claim 42.

1 54. The article of manufacture of claim 53 wherein the machine-accessible medium further
2 includes data that cause the machine to perform the method of claim 45.

1 55. The article of manufacture of claim 53 wherein the machine-accessible medium comprises a
2 recordable storage medium.

1 56. The article of manufacture of claim 53 wherein the machine-accessible medium comprises a
2 carrier wave.